

Lecture [big session]

13 December 2015

11:14 AM

13/12

Sheet 9

9)

$$R = \frac{V}{I} =$$

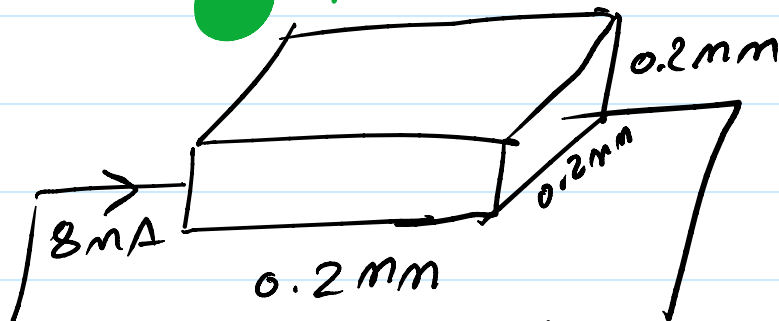
$$R = \frac{\rho L}{A} \rightarrow \rho = \frac{RA}{L} =$$

$$\sigma = \frac{1}{\rho} = qn\mu_e$$

$$n = \frac{\sigma}{q\mu_e}$$

$$J = I/A = qn\mu_e V_d$$

● solution
● another solution
● note



1 Volt

$n = ??$

$V_d = ??$

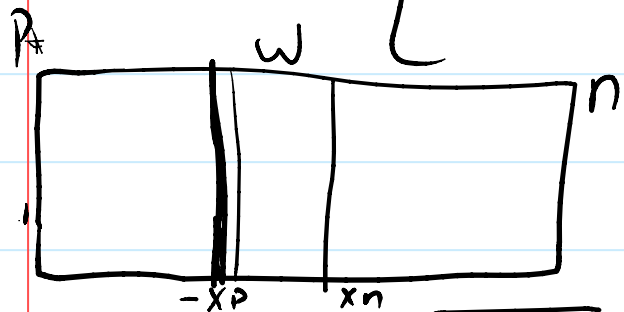
$\mu_n = 1400$

$$E = V/L$$

$$V_d = \mu E$$

$$J = I/A = qn\mu_e V_d$$

$$10) X_n = \left[\frac{2\epsilon_s (V_{bi} + V_R)}{q} \left[\frac{N_A}{N_D} \right] \frac{1}{N_A + N_D} \right]^{1/2}$$



$$w = \sqrt{\frac{2\epsilon (V_0 + V_R)}{qN_D}}$$

$$C' = \frac{\epsilon}{w} = \sqrt{\frac{\epsilon q N_D}{2(V_0 + V_R)}}$$

$$\left(\frac{1}{C'} \right)^2 = \frac{2(V_0 + V_R)}{A^2 \epsilon q N_D} =$$

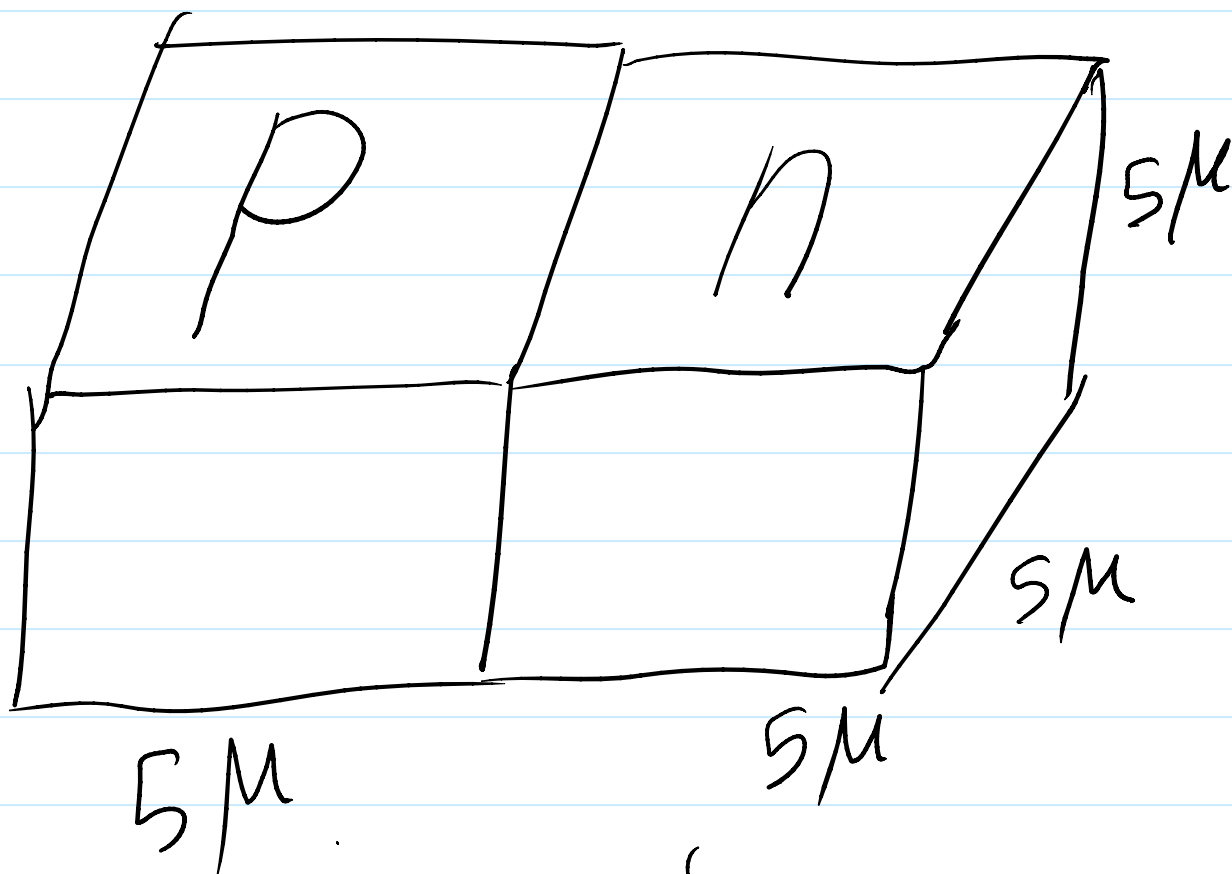
2 $\sqrt{12}$ $2V_0$

$P^+ n$: P is heavily doped



$$= \frac{2}{A^2 \epsilon q N_D} V_R + \frac{2 V_0}{A^2 \epsilon q N_D}$$

11)



$$P = N_A = 10^{14}$$

$$\mu_p = 400$$

$$\mu_n = 1000$$

$$n = N_D = 10^{18}$$

$$\mu_p = 300$$

$$\mu_n = 800$$

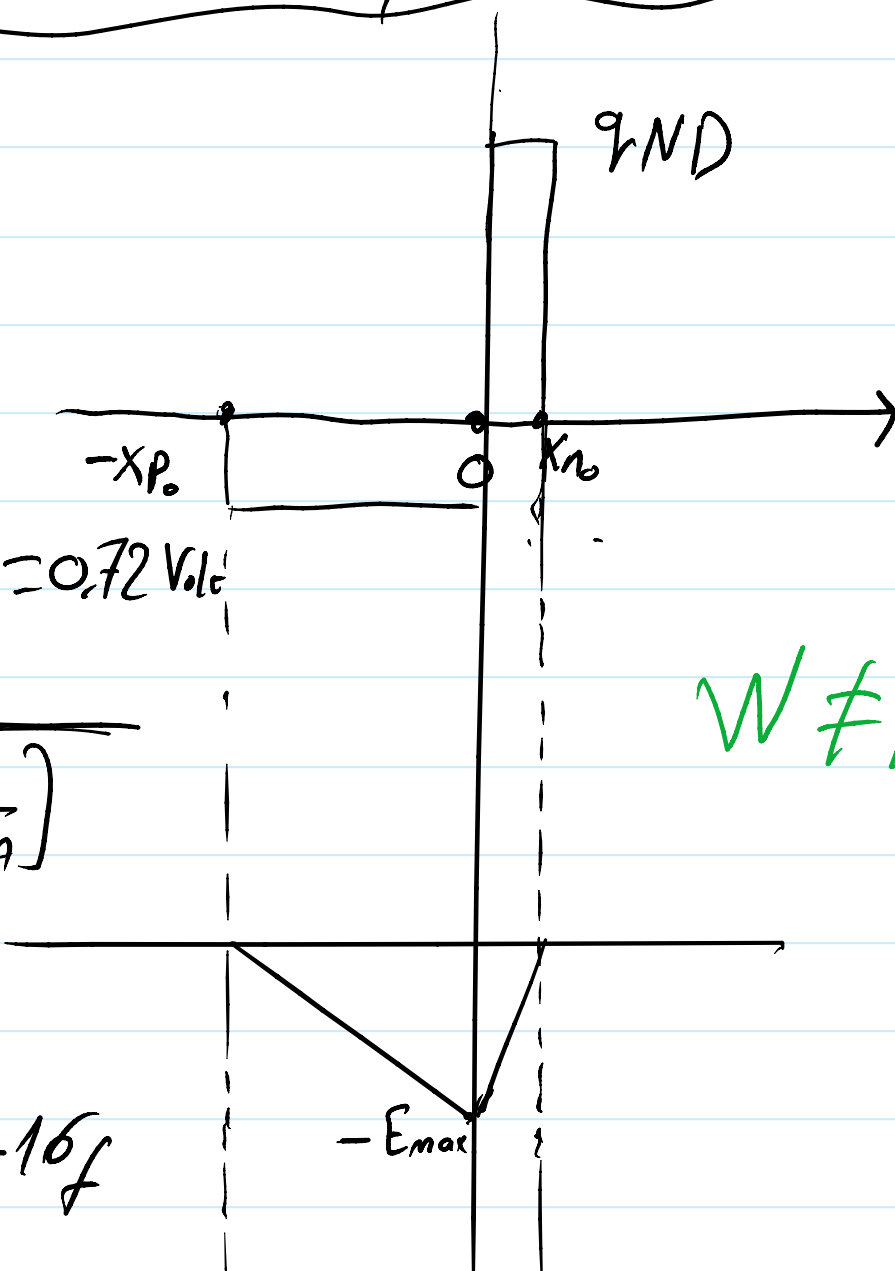


$$V_0 = \frac{kT}{q} \ln \frac{N_A N_D}{n_i^2} = 0.72 \text{ Volts}$$

$$W = \sqrt{\frac{2 \epsilon V_0}{q} \left[\frac{1}{N_D} + \frac{1}{N_A} \right]}$$

$$= 3.05 \mu\text{m}$$

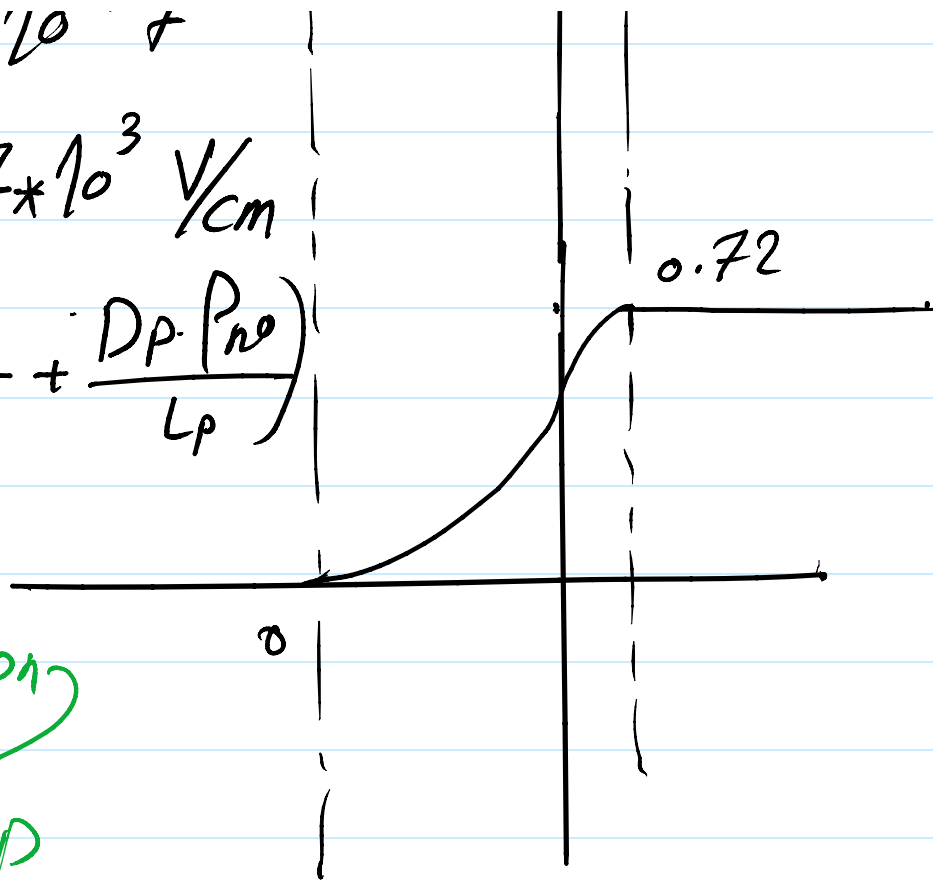
$$C = \frac{\epsilon A}{W} = 8.49 \times 10^{-16} \text{ f}$$



$$C = \frac{W}{L} = 0.1 \times 10^4 \text{ } \mu\text{F}$$

$$E_{max} = -\frac{2V_0}{W} = -4.7 \times 10^3 \text{ V/cm}$$

$$I_0 = Aq \left(\frac{D_n n_{p0}}{L_n} + \frac{D_p p_{n0}}{L_p} \right)$$



$D_n \rightarrow P$ Region
use μ_n of P

$D_p \rightarrow n$ Region \sim use μ_p of n

$$D_n = \mu_n \left(\frac{KT}{q} \right) = 26 \text{ cm}^2/\text{V}\cdot\text{s} \quad \text{Einstein Relation}$$

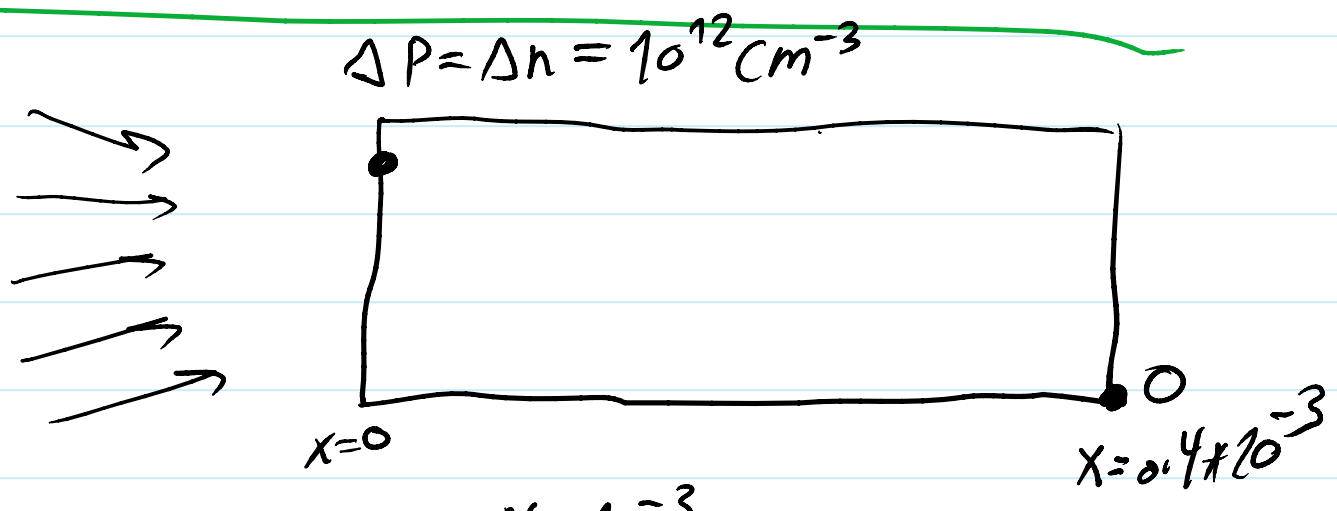
$$D_p = \mu_p \left(\frac{KT}{q} \right) = 7.8 \text{ cm}^2/\text{V}\cdot\text{s}$$

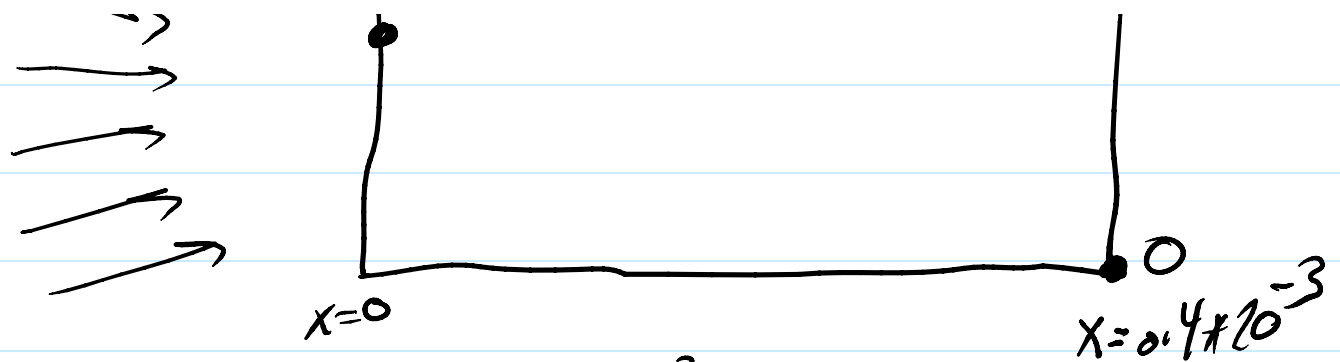
$$I_0 = Aq \left[\sqrt{\frac{D_n}{\tau_n}} \cdot \frac{n_i^2}{N_A} + \sqrt{\frac{D_p}{\tau_p}} \cdot \frac{n_i^2}{N_D} \right] = -4.11 \times 10^{-10} \text{ A}$$

$$I_R = -I_0$$

$$I_f = I_0 \left(e^{V_f / (KT/q)} - 1 \right) = I_0 \left(e^{0.4 / 0.0259} - 1 \right) = 1.97 \text{ mA}$$

12)





$$L_p = 0.4 \times 10^{-3} \text{ cm}$$

use $e^x = 1 + x$

$$D_p \frac{\partial^2 \Delta p}{\partial x^2} - \mu_p E \frac{\partial \Delta p}{\partial x}$$

$x \ll 1$

$$e^x = 1 + \frac{x}{1!} + \frac{x^2}{2!}$$